Suturing Skills eBook

FORWARD

This suturing skills manual is the accompaniment to the workshop that I will now be hosting for the eighth consecutive year. The improved eBook has again been updated and the well received improved layout has been retained. After much debate, the format remains PDF as it is the most well known cross-platform format. It is also easily printed. The layout was designed to be read on a tablet device in landscape mode, or on a computer screen.

You will see blue bars along the left margins of section that are (in my opinion) critically important for the student to know and comprehend. They probably deserve more than one read through.

More importantly this entire document is now available as a PDF eBook which can be downloaded at no cost from my website.

If you have any comments or suggestion to make this resource more valuable, please share them with me.

DR MARSHALL MURDOCH
Plastic & Reconstructive Surgeon

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@DrMJMurdoch

marshall@DrMJMurdoch.co.za

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AN INTRODUCTION TO SUTURES

The approximation of human tissues in an effort to improve healing is an ancient practice, with written references to its use dating back to 2000 B.C. A multitude of materials have been used, from the mandibles of biting insects (the first skin clips?) to filaments of animal hair and sinew, to strands of precious metals. The array of materials available today is no less broad or bewildering!

The ideal suture, like the Holy Grail, has not been found. Our suture choices, therefore, must be a compromise, hence the wide array of choices. Each surgeon will develop a preference or "suture routine" based on the basic principles and modified by patient factors, previous clinical experience and technical competence.

It is important to note that no single surgeon's routine is correct, and that slavish adherence to that routine is certainly incorrect. Clinical experience aids in good suture selection.

An important concept is that of *Knot tensile strength,* which is measured by the force (in *lb*) which the suture can withstand before it breaks when knotted. The accepted rule is that the tensile strength of the suture need never exceed the tensile strength of the tissue in which it is placed. However, sutures should be at least as strong as normal tissue through which they are being placed and if the suture strength reduces over time, the relative rates at which the suture loses strength and the wound gains strength are important. If the suture biologically alters the healing process, these changes must also be understood. The accepted surgical practice is to use the smallest diameter suture that will adequately hold the wounded tissue. This practice minimizes trauma as the suture is passed through the tissue to effect closure. It also ensures that the minimum mass of foreign material is left in the body.

As sutures consist of a needle and a filament, both of which will influence the surgeon's choice, we will look at these two issues separately.

THE NEEDLE

As the needle path determines the suture placement, the performance of a suture is critically related to the needle performance. There are four important criteria that determine needle performance: strength, ductility, sharpness and stability (in the instrument).

Strength is determined by how it resists deformation during repeated passes through tissue. Tissue trauma (both to the surgeon's fingers and the patient's tissues) can be induced if a needle bends during penetration. Maximum strength is determined in the laboratory by bending the needle to 90°, this is referred to as the needle's "ultimate moment". Clinically more useful is "surgical yield point", which indicates the amount of angular deformation the needle can withstand before becoming permanently deformed.
This point is usually 10° to 30° and once deformed beyond this point you should **never** reshape such a needle.

Ductility refers to the needle's resistance to breaking under a given amount of bending. Searching for part of a broken needle can cause added tissue trauma, anesthetic time and litigation! Needle bending and breakage can be minimized by passing needles through tissue in the direction of the curve of the needle body (this will be addressed in the suture workshop). Needles are not designed to be used as retractors to lift tissue.

Sharpness is especially important in delicate or cosmetic surgery. The sharper the needle, the less the trauma and the less scarring that will result. Sharpness is related to the angle of the point as well as the taper ratio of the needle.

Stability of the needle in the grasp of a needleholder is essential for accurate suturing. Needles are flattened as well as ribbed in the grasping area (the middle third) to enhance control by providing a cross-locking action in the needleholder to prevent rocking, twisting, and turning. This action can only occur in the jaws of a **needleholder** and does not occur if an artery forceps is used. Needles should only be grasped in the designated area and never at the tip or the eye.

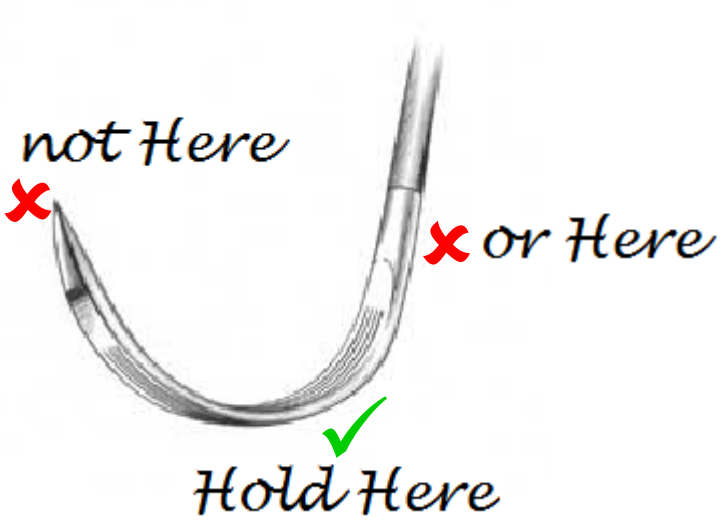


FIG 1 Where to grasp the needle safely

ANATOMY OF A NEEDLE

All needles consist of three basic areas: the tip or point, the body and the eye. In addition, there are several measurements to determine size.

The chord length is the straight line distance from the point of a curved needle to the swage. The needle length is the distance measured along the needle itself from point to eye.

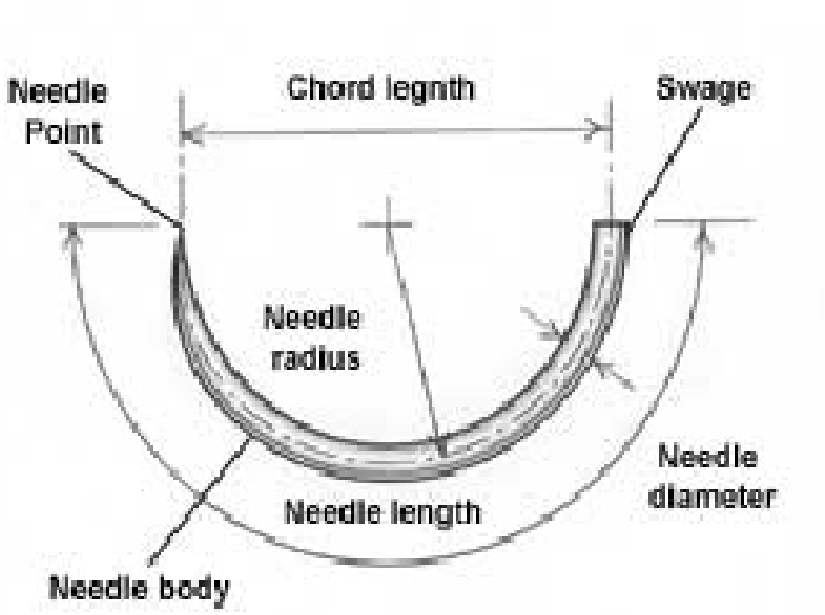


FIG 2 The Anatomy of the Needle

The radius is the distance from the center of the circle to the body of the needle if the curvature of the needle were continued to make a full circle. The diameter or the gauge is the thickness of the needle wire ranging from very fine gauge for microsurgery to large, heavy gauge needles used to penetrate the sternum.

Eyed needles have been relegated to historical texts as all modern needles are swaged.

Swaging is a metal forming technique in which the metal is plastically deformed to its final shape using high pressures, by pressing, hammering, or by forcing through a die. Swaging differs from forging (heated in a furnace and worked hot – like Japanese swords!) in that the swaged metal is cold worked, and the output of the swaging operation is usually the finished shape.

As it relates to sutures, this configuration joins the needle and suture together as a continuous unit that is convenient to use and minimizes trauma, hence such needles are referred to as "atraumatic".

FIG 3 *Left* Swaged Eye, *Middle* Mayo Eye, *Right* French Eye

The method of attaching the suture to the needle varies with the needle diameter. In larger diameter needles, a hole is drilled in the needle end. In smaller diameter needles, a channel is made by forming a "U" at the swage end or a hole is drilled in the wire with a laser. Each hole or channel is specifically engineered for the type and size of suture material it will hold, and crimped or closed around the suture to hold it securely. Some needles are designed to be released from the swage with a sharp tug when the surgeon has finished placing the suture line. These needles are called "CONTROL RELEASE" needles (or "Pops" if you live in America…).

THE NEEDLE BODY

Needles come in a variety of shapes, designed to assist the surgeon by making the passage of the needle through the tissues as ergonomic and atraumatic as possible. **APPENDIX 1** describes the most common needle shapes and applications.

THE NEEDLE POINT

The point extends from the extreme tip of the needle to the maximum cross-section of the body. Each needle point is designed and produced to the required degree of sharpness to smoothly penetrate specific types of tissue. **APPENDIX 2** describes the most common needle points and their applications.

THE FILAMENT

The thread that is used to approximate tissues is often given primary importance, as this is what is left in the patient. The choices are bewildering and you must remember that not every surgeon will use all the possible types. As in pharmacology, sutures often come with two names, one is the raw material (generic name) and the other is the brand name (trade name). It makes sense to be well acquainted with both names since different brands will be used in each hospital that you visit. To aid in your memory, and to assist you in making rational suture material choices, sutures can be divided into groups on a physical or chemical basis:

There are three ways of classifying suture material:

a. Natural Vs. Synthetic (Neither obvious nor terribly helpful)
b. Monofilament Vs. Braided (Marginal clinical significance)
c. Absorbable Vs. Non-Absorbable (Clearly the most important)

The division on absorbability is the most clinically useful, since it will determine follow up protocols, affect the healing process and have potential long term implications. It is of course quite helpful to know all the physic-chemical properties of the sutures that you will be using.

A useful overview is included in **APPENDIX 3 A and B AND APPENDIX 4 A and B** at the end of this manual.

SIZES

The length of suture in the packet is usually printed on the package, but the size usually refers to the diameter of the filament. There are two sizing standards : Metric and U.S.P. (which stands for United States Pharmacopoeia – a Federally governed formulary which sets standards for drugs and other medical devices like sutures. Similarly the letters B.P. on medications like calamine lotion stand for British Pharmacopoeia). The diameter is given a size designation based on the ability of the thread to hold a certain force without snapping.

Sizes are a range of diameters and are different for absorbable and non-absorbable (for which there are three sub-classes). That is to say, 5/0 steel is different in diameter to 5/0 chromic, but all 5/0 steel from any manufacturer must be of equivalent size and strength as specified in the U.S.P. guideline.

The U.S.P. sizes vary from 5 (elephant suture) to 13/0 (super-microsurgery). The scale below gives an idea of the range. The designation /0 is used for convenience and means smaller as 0 is smaller than 1 and 00 (or 1/0) is smaller and 000000 or (5/0) is even smaller. The standard available range is size 2 to size 11/0. Size 7/0 and smaller are for use with special instruments and require additional training.

BIGGEST SMALLEST

5 4 3 2 1 0 1/0 2/0 3/0 4/0 5/0 6/0 7/0 8/0 9/0 10/0 11/0 12/0 13/0

Clinical Use with standard tools | **Microsurgical Use**

TABLE 1 The U.S.P. sizing chart of available sutures.

The Metric size (one has to love the French) is the suture diameter in tenths of a mm and can be related (more or less) to the U.S.P. size. by the following table . This is however dependent on the type of material in question, since the U.S.P. Remember that metric refers to an exact size (measurable) whereas U.S.P. refers to some arbitrary American guideline – check it out for yourself sometime: 4/0 chromic and 4/0 silk are of different

U.S.P.	Metric
5	7
4	6.5
3	6
2	5
1	4
0	3.5
1/0	3.0
2/0	2.5
3/0	2.0
4/0	1.5
5/0	1.0
6/0	0.7
7/0	0.5
8/0	0.4
9/0	0.3
10/0	0.2

TABLE 2 The conversion USP to Metric for absorbable material.

USE OF WEAPONS

Knowing how to hold your instruments correctly makes you safer, more proficient and more efficient. The practical side of the workshop will focus on this extensively. Despite some initial difficulties you should focus on holding and using the surgical instruments correctly from the very first time. Poor technique and bad habits are very difficult to undo if they become entrenched in your formative training.

SUTURE TECHNIQUES

More than any of the above subjects, this area is subject to the greatest degree of personal interpretation. As long as you adhere to the basic principles you can add your own flair (the second of Gillies' 10 commandments of Plastic Surgery is "Thou shalt have style").

This is not to say that your stitch craft can be haphazard – good suturing is like making risotto – even professionals need to pay meticulous attention every time or the outcome may still be poor.

As all surgical instruments with a hinge (such as scissors and needleholders) are designed to be used in the right hand. This is because the ratchet lock is uni-directional on needleholders and scissors have their mechanical cutting advantage in one plane only.

Left handed surgeons are at an immediate disadvantage. If you are left handed, do not be put off by this initial difficulty. Once you master the use of a right hand instrument in your left hand, this will become an extremely valuable advantage.

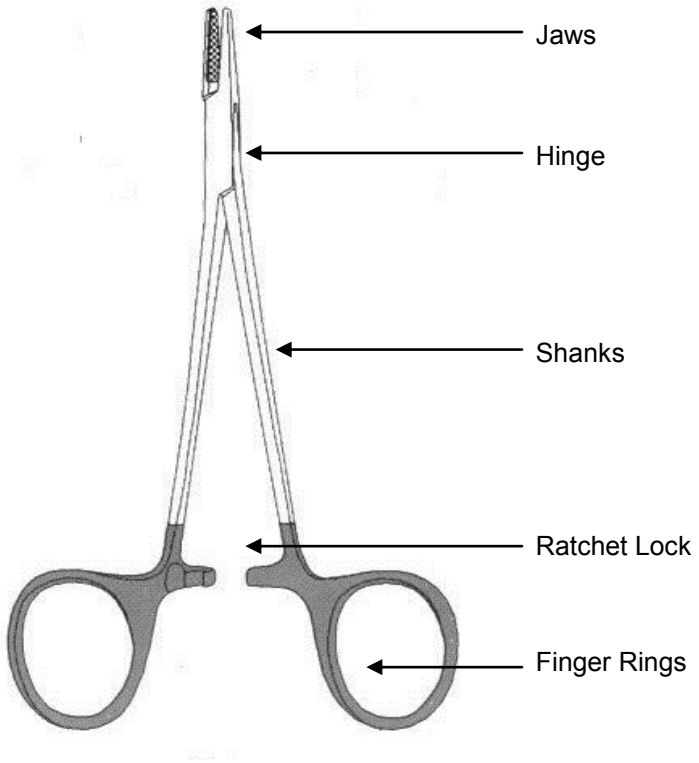


FIG 4 The Anatomy of a Needleholder

Consider the occasional need for using an instrument in your non-dominant hand. Right handed surgeons are now at a double disadvantage: their non-dominant hand and the mechanical disadvantage of the instrument.

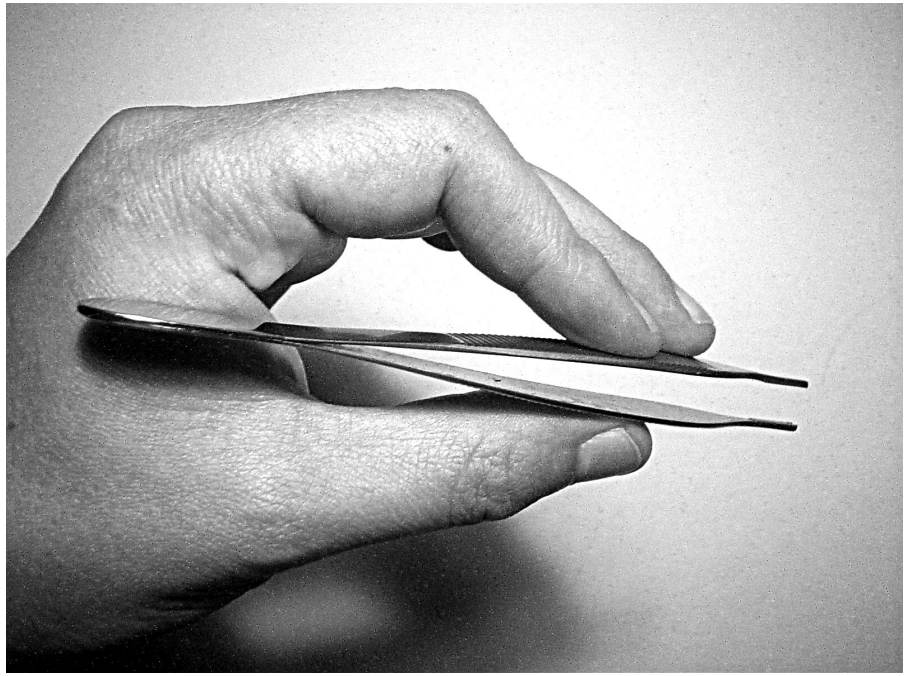
Many of great names in Plastic Surgery, both past and present (and no doubt future) have been left handed!

The needleholder is held in the dominant hand, with the thumb and ring fingers in the instrument's rings. The middle finger is placed on top of the ring, and the index finger acts as a stabilizing strut along the finger-side shank of the instrument. The instrument should rest no more proximally than the distal interphalangeal joints of the fingers, for finer work the instrument is grasped with the pulps of the fingers as they have the greatest sensitivity. While such as position may initially feel precarious, a small time investment will pay-off handsomely later.

To open the needleholder, the instrument is braced on the thumb and flexion of the fingers opens the ratchet lock and frees the jaws.

To grasp the needle simply squeeze the instrument's rings together until the ratchet lock "clicks". Ideally only one click should be necessary if the instrument is of good quality (not many are, unfortunately). All standard needleholders have the ratchet lock set for a right-handed surgeon. The forceps should be held in the non-dominant hand like a pen. The index and middle fingers both grasp the shank opposite the thumb for greater control.

NEVER retrieve a needle from the tissue with your fingers. Avoid the (almost) irresistible temptation to reposition the needle with your fingers – this bad habit is VERY difficult to unlearn.



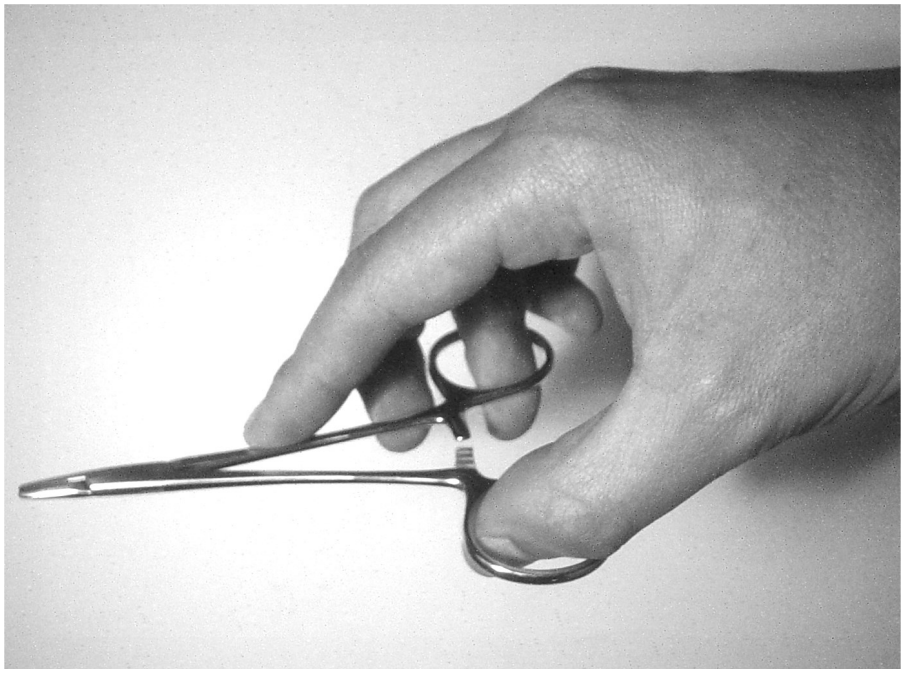


FIG 5 & 6 The correct technique of holding a needleholder and forceps (for a right handed surgeon) is demonstrated. Note that the needleholder is held in the dominant hand and the forceps in the non-dominant hand.

YOUR FIRST SUTURE

Placing your first suture is a daunting, exhilarating and often time consuming exercise (I took 60 minutes for my first 5 sutures!). Do NOT be concerned with time, the good surgeon does not watch the clock, since stitch craft is not a race. **First you must be good, then you can become fast**. The best surgeons are not fast because their individual movements are quick, they are fast because they have mastered economy of motion. It is also much faster to put a suture in once rather than having to re-do it 2 or three times.

Placing a suture requires 2 equally important parts: driving the needle through the tissue and then trying the knot.

PART 1: DRIVING THE NEEDLE

Start by loading the needle in the needle holder, grasping it in the designated area only. Alternatively, the needle may be loaded by the scrub nurse or assistant and handed to you. This is **STEP 1**.

FIG 7 Load the needle into the needleholder in the area as shown. It should be securely grasped in the distal tip of the jaws.

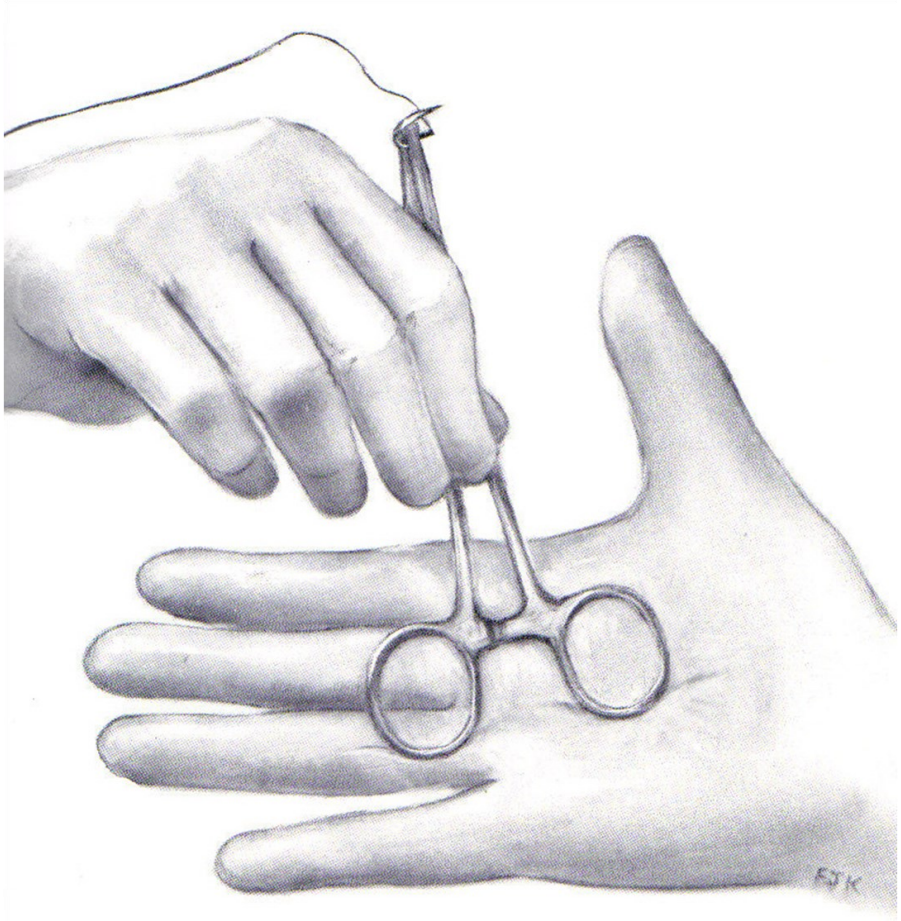


FIG 8 When passing or receiving a needleholder which is already loaded with a suture, the correct technique is shown above. Note that the surgeon receives the rings with an open palm. The fingers are positioned only once the instrument is firmly in the surgeons hands only. Also note that the assistant grasps the instrument by the shanks, with the needle facing AWAY from their hand. In this way injury to either surgeon or assistant can be avoided. The same technique is also used for passing other hinged instruments.

STEP 2: To drive the needle through the tissue, first pronate your wrist so that the needle will enter the skin perpendicularly (See FIG 9). Some surgeons like to remove the thumb from its ring to avoid wrist strain – this is matter of personal style. The edge of the skin may be everted with the forceps or skin hook to aid in getting the needle perpendicular. The needle is driven through the tissue by supination of the hand only and no forward action is required. The arc of the needle determines the arc of supination required. Thus larger radius needles require less supination than smaller needles. Except in the most scarred of tissues, needle passage is smooth and occurs with minimal resistance – if you have to "push" the needle your action is invariably incorrect.

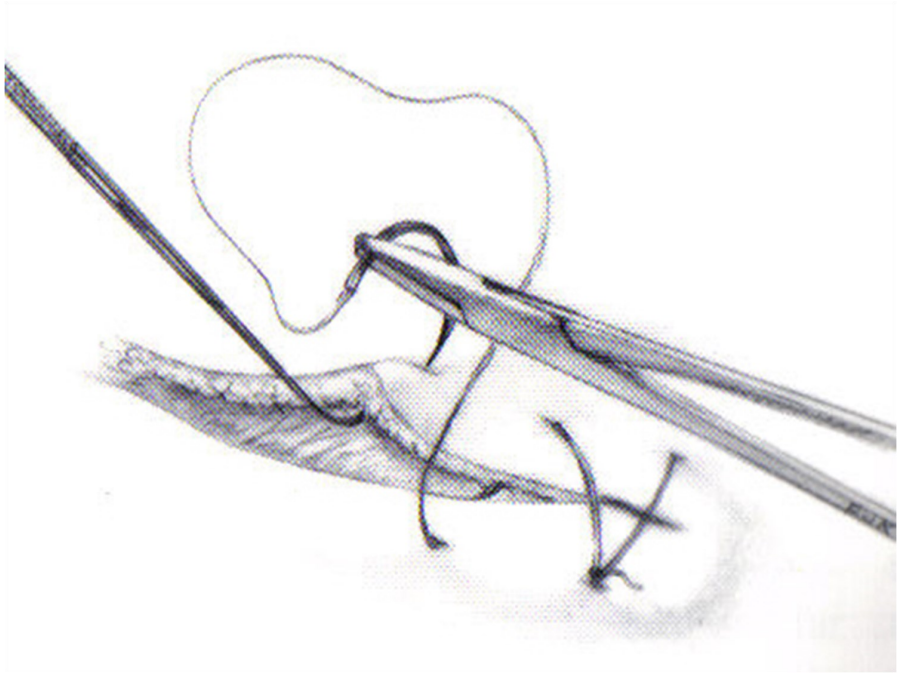


FIG 9 The combination of edge eversion (with forceps or skin hook as shown) and wrist pronation results in optimal placement

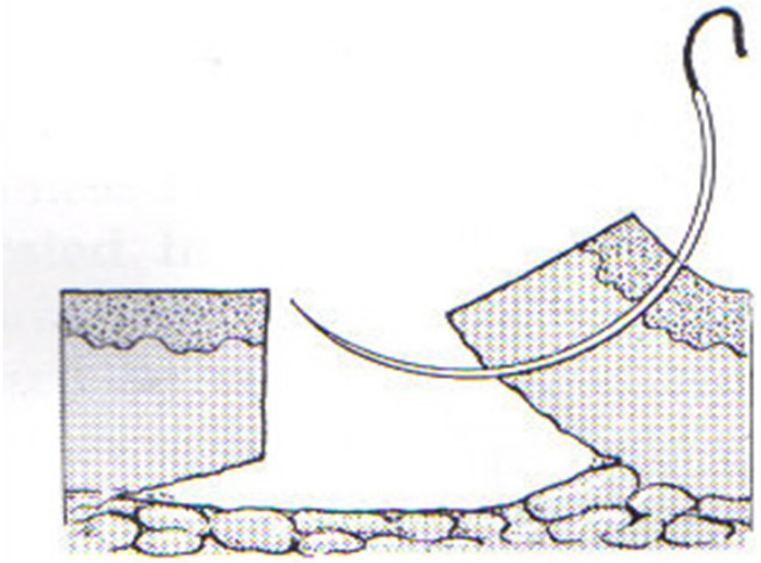


FIG 10 An "even bite" occurs when the distance from entry to tissue edge is the same as the distance from exit to tissue edge.

When the correct action just described is employed, then the "bite" you have taken will be even. This is an important concept. The "bite" is the amount of tissue captured by the needle's passage and an even bite is when the distance from entry point to tissue edge is equal or slightly smaller than the distance from exit point to tissue edge (see **FIG 10**) This gives the suture a square or slightly rhomboid shape in cross section. When tightened, this aids in the slight eversion required to get optimal edge apposition.

In general, sutures should be placed so that you drive the needle from the dominant to the non-dominant side, and from further to closest. This is mechanically the most advantageous and aids in surgeon comfort and optimal results.

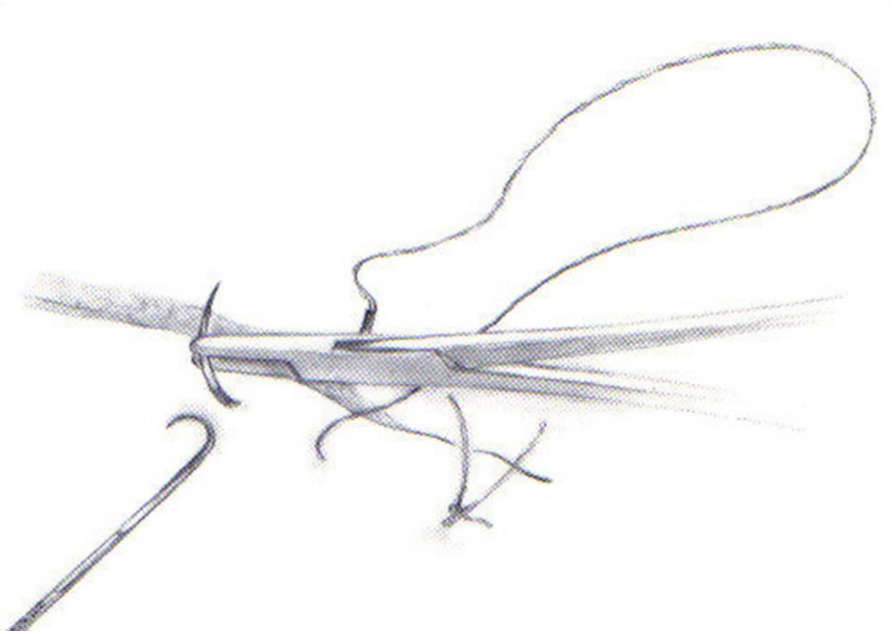


FIG 11 The needle may be retrieved with either the forceps of the needleholder, but it is critical to avoid grasping the tip.

STEP 3: Retrieve the needle with the forceps, avoiding the delicate tip area, and reload the needleholder (See **FIG 11**). As the tip area is thinner, it is easily bent or the cutting surface dulled—this make it more difficult to place another suture and increases the risk of injury. Perform an equal bite on the opposing wound edge as before (See **FIG 12 A,B**). Care must be taken to ensure that the suture is placed at the same depth on each side of the wound. As you gain confidence and skill you may wish in certain circumstances to take bites of both wound edges in a single movement. This is more challenging and in inexperienced hands likely to cause unequal bites with poor approximation.

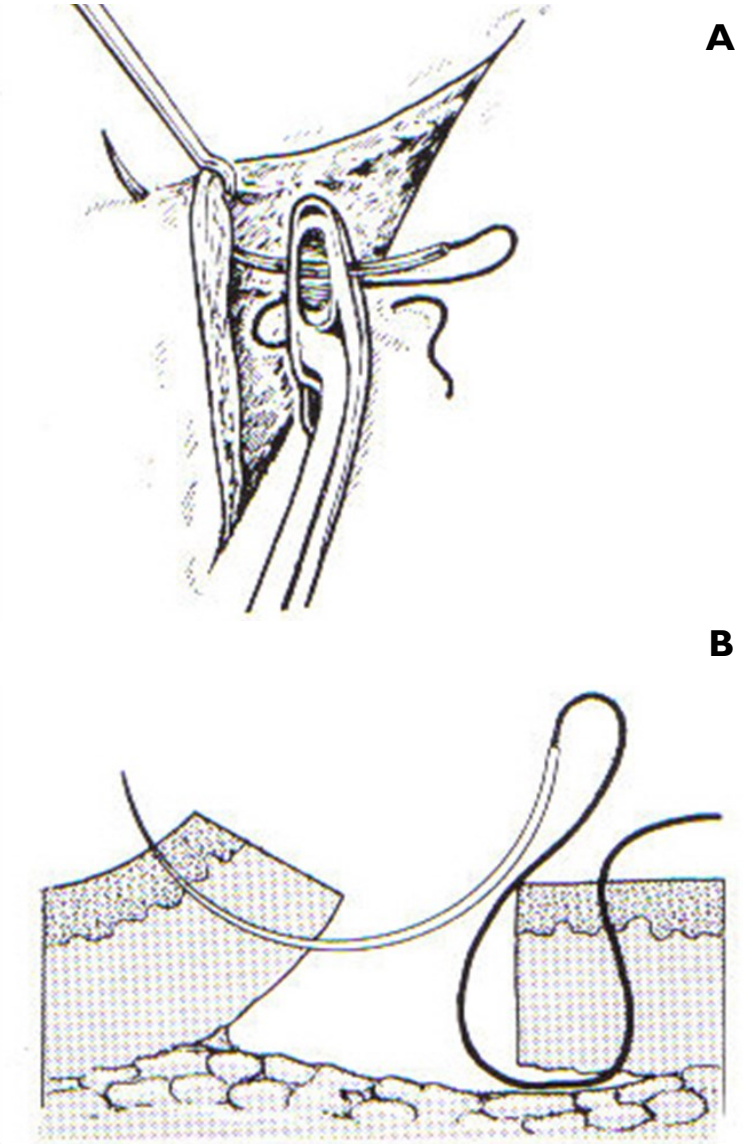


FIG 12 A & B The same action is used to drive the needle through the apposing tissue edge.

PART 2: KNOT TYING

Knots may be tied with an instrument or with the fingers. Generally, when suturing, the knots will be tied with an instrument. This tends to be faster and wastes less suture, which have cost implications.

Accurate, sturdy knots are critical to successful stitch craft – I have witnessed knots untying while the patient is still on the table. **All knots, no matter where, must be "square" and must be "locked" by the additional throws for adequate security**. These concepts will be emphasized during the workshop (See **FIG 13**).

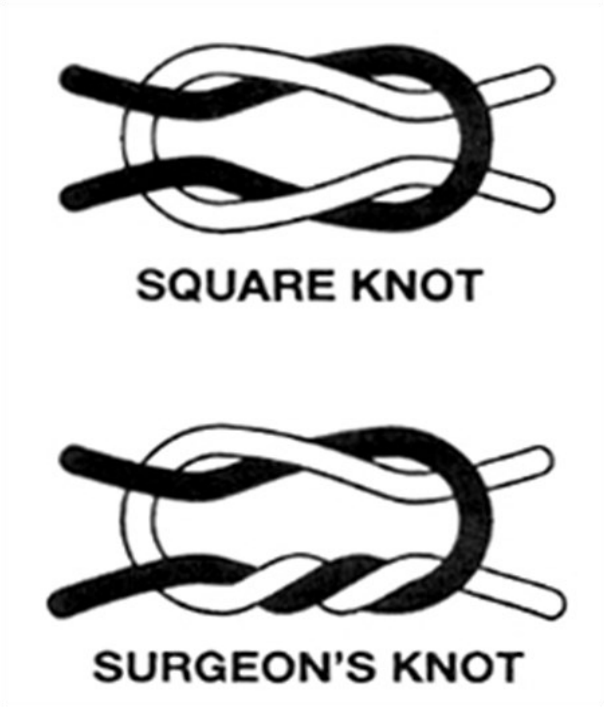


FIG 13 A "Square" or "Reef" knot has a symmetrical interlacing of the two threads. A "Surgeon's" knot is a square knot with addition throws.

STEP 1: Start by grasping the "long" end of the thread between your index and thumb of your non-dominant hand. Leave an appropriate length between your fingers and the skin edge, to tie with ease. Too long and the thread becomes unwieldy, too short and you risk pulling the end out of the tract (your preference will be determined by skill and setting – for me this is about 8-13 cm). Loop this length 2 or 3 times over the needleholder end (clockwise, looking down the shanks),

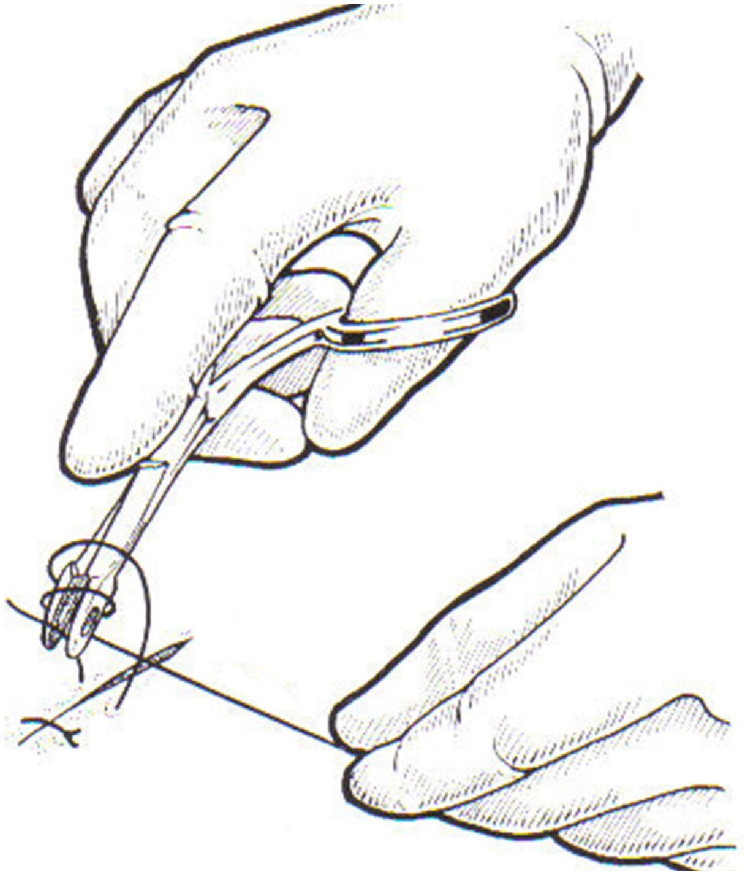


FIG 14 Start with 2 or 3 clockwise "throws" around the needleholder.

STEP 2: Grasp the short end in the jaws and complete the first knot by pulling the short end to the opposing edge, while pulling the long end in the opposite direction. In other words, if the short end is on the upper left, it should be pulled to the lower right.. Similarly the long end is pulled in the opposite direction. (See **FIG 15**). If this rule is adhered to then the creation of square knots is greatly simplified.

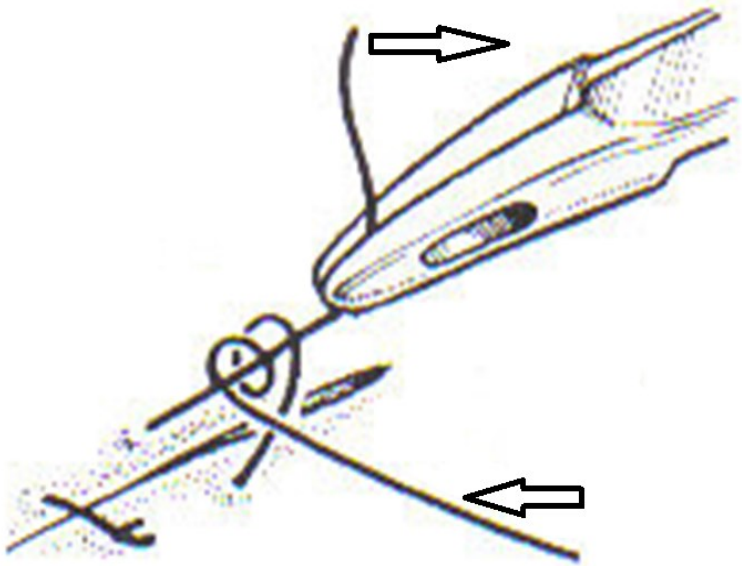


FIG 15 The suture ends should be pulled to the opposite sides of the wound. Where possible, the surgeon should be positioned in such a way as to avoid crossing their arms to achieve this.

STEP 3: For the next throw, loop the "long" end under (anticlockwise) the needleholder (**FIG 16**), grasp the short end in the jaws and pull the short end back to the original side while pulling the long end in the opposite direction (**FIG 17**), this will result in a "square" or "surgeon's" knot.

The guiding principle is that the throw direction and the short end pull must alternate directions on every throw.

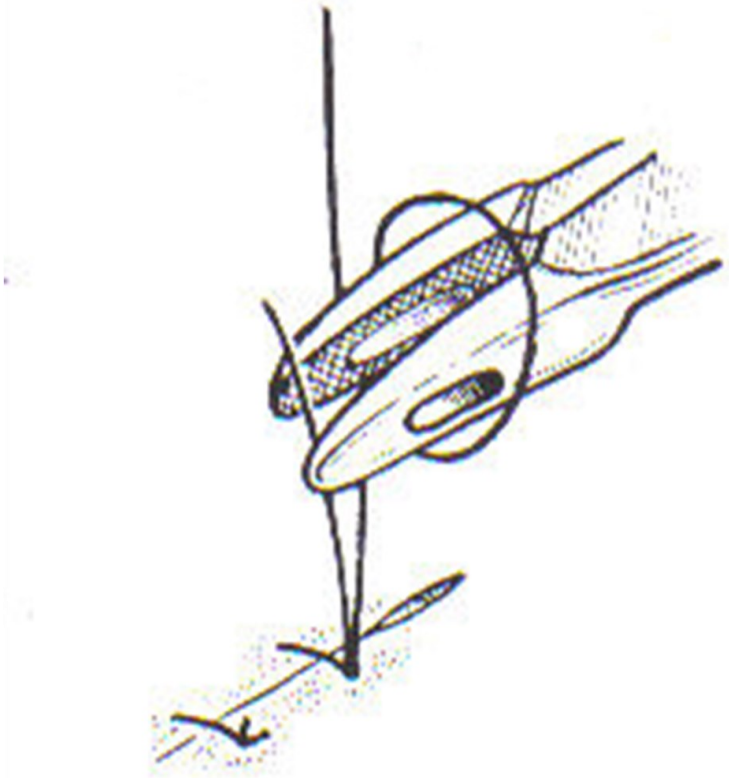


FIG 16 The suture is looped under the needleholder. This is the opposite way to that shown in **FIG 14**.

FIG 17 Once again, the suture ends should be pulled to the opposite sides of the wound. This will be in the opposite direction to that shown in **FIG 15**.

STEP 4: Add more "throws" in the same manner alternating the direction of the throws and the directions of the pull, in order to make square, locked knots.

The number of throws required is determined by tension and the "slipperiness" of the material, but 4 throws is probably the minimum, I use 4 for nylon, 5 or 6 for monocryl and vicryl, 7 for PDS II and up to 9 for prolene which has a very low friction co-efficient. It is probably impossible to give hard and fast rules on how tight to tie each knot as this is the area most subject to clinical intuition, but here is a rough metaphor: the first throw should be pulled until the wound edges just "kiss" (the way you kiss your cousin – lightest contact and nothing more!). The second throw should be pulled until it "locks" the first.

The third throw should be pulled until "tight" – if the previous throws have been locked properly, they will have "set" the wound edges and tightening the third throw should have no real effect on the wound edges. More throws are added as required.

How far away should the next suture be placed? Again, it is not possible to give an absolute value but sutures are usually placed approximately 5 mm to 7 mm apart and 1 mm to 3 mm from the skin edges, although the anatomical location and size of the needle and caliber of the suture material make this somewhat variable.

SUTURE CUTTING

Cutting the suture is the final step and is a subtle art, often performed very badly.

If the suture is to remain in situ then the ends should be cut as short as possible to minimize foreign material in the wound. Place the one blade on the knot, angle the other at 45° upwards and cut – this will avoid the exasperating experience of cutting through the knot.

Cutting sutures that will have to be removed is a more precise exercise, and each surgeon has his or her preference. **The general principle is to cut the length long enough so that it can be easily removed later, but short enough to prevent the ends being caught up in the next suture** – an enormously irritating occurrence. As a rough guide, a length of 6mm is adequate (See **Fig 18**).

The exercise of removing sutures that have been placed and cut by yourself is an excellent lesson in gauging the appropriate length. All too often this is delegated to the most junior member of staff or nurse. If badly performed, this can have disastrous effects on wound healing and subsequent scarring.

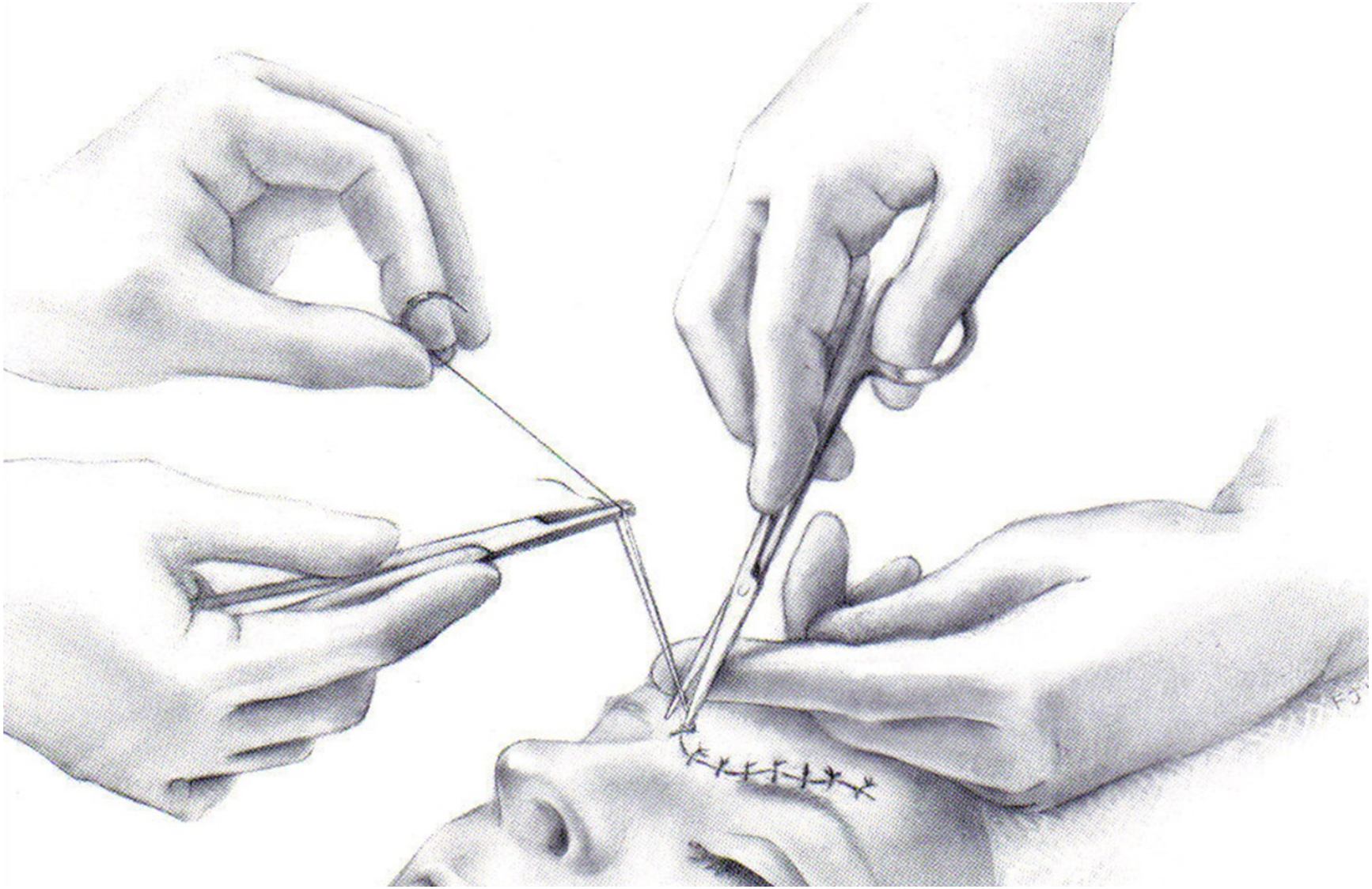


FIG 18 The correct technique for cutting sutures is demonstrated. The assistant uses their non-dominant index finger as a stabilizing strut to prevent tremor and to allow an accurate judgement of suture length. Not also the unspoken, universal sign requesting the suture to be cut: the surgeon folds the long end over the needleholder and holds the two threads perpendicularly presenting them to the assistant.

SUTURING IN THE REAL WORLD

Ambroise Paré a famous French surgeon presented this dictum (among others) in 1564 – "Restore to their places things which are displaced". When faced with long jagged laceration, inexperienced surgeons may become dismayed – do something positive. Start with two edges that definitely fit and work from there – you will oftentimes be surprised at your ability to close the most daunting of lacerations. Sometimes there may be nothing obvious to guide you. Here the technique of "halving" the laceration may be valuable to prevent "dog-ears" at the ends due to edge length mismatch.

REMOVING SUTURES

Again, this area generates controversy and confusion but guiding principles are available. The timing depends on the anatomical site, the progress of wound healing, the wound tension and the desired cosmetic result. Epithelialization of the suture tract develops within 10 days, and persists long after suture removal if allowed to develop. This causes comedone-like lesions of heaped up keratin at the entry and exit sites and sometimes along the deeper tract – this results in the "railroad scar" An interesting and widespread (but off-code) use of cholamphenicol eye ointment is application to the suture line prior to dressing – this lubricates the suture, allows it micro-movement in the tract and subsequently decreases epithelialization of the tract.

The face with its excellent blood supply usually heals well and is of prime cosmetic importance. Sutures should be removed on day 5 to 7 (latest). In other areas a strong wound is of greater importance than cosmesis and sutures can be left for 10 days to 2 weeks. In cosmetically important areas such as the breast, intradermal techniques which do not require removal are preferable.

Sutures should be removed with the same care that they are inserted with. A fine non-toothed forceps and a sharp pair of iris scissors are the tools of choice, a stitch cutting blade is barbaric, painful and may cause multiple small areas of dehiscence - it cannot be recommended. Always pull the cut end over the wound to remove, never away as this causes force vectors that act to open the wound.

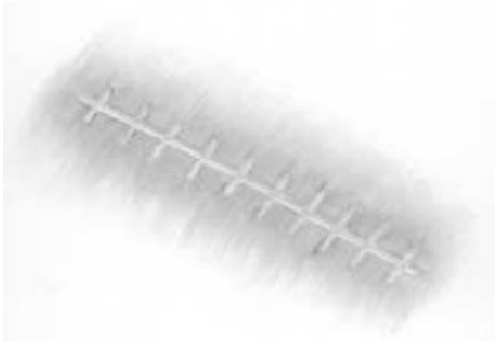


FIG 19 A "railroad" scar has many causes, including overly tight sutures, poor technique and sutures that have been left in for excessive periods. Sub-cuticular techniques eliminate this problem.

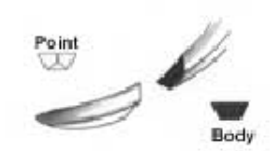
THE SMALL STUFF

Dr Phil may not want you the sweat the small stuff, but the finer points of wound closure can be the difference between an unattractive, poorly healed scar and an imperceptible one. The wound edges must come together precisely or in very slight eversion. **Inversion is absolutely verboten!** In simple interrupted sutures where there is minimal tension, the technique described above is sufficient.

In other clinical scenarios different suture technique may be applicable. These more advanced techniques are best learned when simple suturing has been mastered. A montage of some of these technique is presented in the following appendices.

Needle Body Shape	Typical Applications
Strait Needle	Designed to be held in the fingers, much like a darning needle. The Keith needle is still used for tendon repairs and the Sims needle for subcuticular closure. The Bunnell needle was used for tendon repairs. A transchamber needle was used for intraocular lens placement. The above strait needles are now uncommon and can be considered a surgical curiosity.
Half-curved / ski needle	The low profile (point-on view) allows easy passage down laparoscopic trocars, and this is where it finds its best application. Its use in skin closure is limited because, while the curved portion passes through tissue, the strait portion is unable to follow with ease.
¼ Circle Needle	Used for ophthalmic and microsurgical applications because of the limited amount of pronation and supination required to pass the needle through delicate tissues.
3/8 Circle Needle	Curved needles allow predictable needle turnout from tissue and require less space for maneuvering than a straight needle. The 3/8 circle is most commonly used for skin closure. The surgeon can easily manipulate this curvature with moderate wrist action in a relatively large and superficial wound. It is very difficult to use this needle in a deep body cavity or restricted area because a larger arc of manipulation is required.
½ Circle Needle	The 1/2 circle needle was designed for use in a confined space, although it requires more pronation and supination of the wrist to pass it through the tissues. Commonly used for gastrointestinal tract surgery, nasal and oral cavity and pharynx surgery as well as pelvic and uro-gential surgery. It is difficult to use for skin closure.
5/8 Circle Needle	A 5/8 circle needle may be more useful than the 1/2 circle where space for manipulation is extremely limited, especially in some anal, urogenital, intraoral, and cardiovascular procedures. Skin closure with such a needle is impossible.
Compound Curved	Developed for anterior segment ophthalmic surgery as the tight curvature of the tip follows into a shallower curvature throughout the remainder of the body. The initial curve allows short, deep bites into the tissue. The curvature of the remaining portion of the body forces the needle out of the tissue, everting the wound edges and permitting a view into the wound. Equal suture bites on both sides of the corneal-scleral junction minimizes the possibility of astigmatism .

APENDIX I

Needle Tip Shape	Typical Applications
Conventional Cutting	Cutting needles have at least two opposing cutting edges. They are sharpened to cut through tough, difficult-to-penetrate tissue. Cutting needles are useful for skin sutures that must pass through dense, irregular, and relatively thick connective dermal tissue. Because of the sharpness of the cutting edge, care must be taken in some tissue such as tendon to avoid cutting through more tissue than desired. Conventional cutting needles have a third cutting edge on the *inside* concave curvature of the needle. The shape changes from a triangular cutting blade to that of a flattened body. This needle type may be prone to cutout of tissue because the inside cutting edge cuts toward the edges of the incision or wound. Sternotomy needles are typically conventional cutting.
Reverse Cutting	These needles were created specifically for tough, difficult-to-penetrate tissue such as skin and tendon. Reverse cutting needles are used in ophthalmic and cosmetic surgery where minimal trauma, early regeneration of tissue, and little scar formation are primary concerns. The reverse cutting needle is as sharp as the conventional cutting needle, but its design is distinctively different. The third cutting edge is located on the *outer* convex curvature of the needle. This offers several advantages: They have more strength than similar-sized conventional cutting needles and the danger of tissue cutout is greatly reduced since the hole left by the needle leaves a wide wall of tissue against which the suture is to be tied.
Side-Cutting Spatula 	Also referred to as *spatula needles*, they feature a unique design, which is flat on both the top and bottom, eliminating the undesirable tissue cutout of other cutting needles. The side-cutting edges are designed for ophthalmic procedures. They permit the needle to separate or split through the thin layers of scleral or corneal tissue and travel within the plane between them. The optimal width, shape, and precision sharpness of this needle ensure maximum ease of penetration, and gives the surgeon greater control of the needle as it passes between or through tissue layers. The position of the point varies with the design of each specific type of spatulated needle. Another useful application is the suturing of nailbed lacerations for the same reasons as above.
Taper	Also referred to as *round needles,* taper point needles pierce and spread tissue without cutting it. The needle point tapers to a sharp tip and the needle body then flattens to an oval or rectangular shape. This increases the width of the body to help prevent twisting or turning in the needleholder. Taper point needles are usually used in easily penetrated tissue such as the peritoneum, abdominal viscera, myocardium, dura, and muscle. They are preferred when the smallest possible hole in the tissue and minimum tissue cutting are desired. In muscle & fascia, taper point needles minimize the potential for tearing the thin connective tissue lying between parallel and interlacing bands of denser tissue.
Blunt	Blunt point (BP) needles also called *dolphin-nose needles* can literally dissect friable tissue rather than cutting it. They have a taper body with a rounded, blunt point that will not cut through tissue. They may be used for suturing the liver and kidney. Due to safety considerations, surgeons also use blunt point needles in obstetric and gynecological procedures when working in deep cavities which are prone to space and visibility limitations.

Suture Card

Non-Absorbable Sutures	Structure	Composition	Coating	Colour	Sizes
Premilene®	Monofilament	Polypropylene	Uncoated	Blue	USP 10/0 to 1 Metric 0,2 to 4
PremiCron®	Braided	Polyester	Silicone	Green White	USP 6/0 to 3 Metric 0,7 to 6
Dafilon®	Monofilament	Polyamide	Uncoated	Blue Black Undyed	USP 11/0 to 1 Metric 0,1 to 4
Supramid	Monofilament (USP 5/0 - 6/0) Pseudomonofilament (USP 3 - 4/0)	Polyamide	Sheath of undyed or black dyed polyamide 6	Black White	USP 6/0 to 3 Metric 0,7 to 4
Trelon®	Braided	Polyamide	Silicone	Black White	USP 6/0 to 3 Metric 0,7 to 6
Dagrofil®	Braided	Polyester	Uncoated	Green White	USP 6/0 to 8 Metric 0,7 to 10
Silkam®/ Virgin Silk	Braided (Silkam®) Twisted (Virgin Silk)	Silk filaments	Wax and Silicone (Silkam®) Uncoated (Virgin Silk)	Black, White Blue (V. Silk)	USP 10/0 to 6 Metric 0,2 to 8
Linatrix®	Twisted	Flax fibers of linen	Silicone and polyvinyl solution	Natural White	USP 3/0 to 3 Metric 2 to 6
Steelex®	Monofilament Twisted	Stainless steel	Uncoated	Metallic	USP 5/0 to 7 Metric 1 to 9

APPENDIX 3 A

Colour	Suture Name	Raw material	Classification	Absorption	Uses
Light Blue	Black Silk PERMA-HAND	Silkworm cocoons. Must be de-gummed and de-waxed and dyed black	**NON-ABSORBABLE**, NATURAL, BRAIDED	Tensile strength = 1 year Absorption = 2 years. Is in reality a slowly absorbing suture	Has the ultimate handling properties, but is highly reactive in the tissues. Useful in eyelid margin suture (because of its softness)
Ochre	Stainless Steel	316 L high grade steel alloy with nickel and chromium. 316 has the lowest carbon of the 3 series.	**NON-ABSORBABLE**, NATURAL, MONOFILAMENT	Tensile strength = many years Absorption = indefinite	A very biocompatible material (but does not osseo-integrate). Useful for sternal closure and some tendon repairs.
Green	Nylon ETHILON	Polyamide polymer of hexamethylene diamine and adipic acid	**NON-ABSORBABLE**, SYNTHETIC, MONOFILAMENT	Tensile strength = 2 years Absorption = indefinite but fragments over time	Minimal reaction with good handling properties. Most useful suture – skin, tendon, ligament are all good applications.
Turquoise	Polyester MERSILENE	Polymer of polyethylene terephthalate, tightly braided into a multifilament strand. Ethibond is identical to mersilene except for a polybutilate coating	**NON-ABSORBABLE**, SYNTHETIC, BRAIDED	Tensile strength = many years Absorption = indefinite	As a braided suture, they have excellent handling properties, no meaningful degradation over time and minimal tissue reaction. Strict asepsis required as the braids may harbour bacteria. Most useful for cardiothoracic (valve) surgery and joint capsule repair and hernia surgery
Orange	Polyester ETHIBOND EXCEL				
Deep Blue	Polypropylene PROLENE	Isostatic, highly unsaturated hydrocarbon polymer	**NON-ABSORBABLE**, SYNTHETIC, MONOFILAMENT	Tensile strength = many years Absorption = indefinite	Very unreactive monofilament, but requires multiple throws to knot. Used in vascular repairs as minimal platelet adherence occurs on its smooth surface
Cranberry (Yup, that's what they call it!)	Poly (hexafluoropropylene- VDF) PRONOVA	Co-Polymer of vinylidene fluoride and cohexafluoropropylene.	**NON-ABSORBABLE**, SYNTHETIC, MONOFILAMENT	Tensile strength = many years Absorption = indefinite	Resists infection and has been successfully employed in contaminated and infected wounds to eliminate or minimize sinus formation & extrusion.

APPENDIX 3 B

Suture Card

Absorbable Sutures	Safil® Quick+	Safil®	Monosyn® Quick	Monosyn®	MonoPlus®	MonoMax®
Structure	Braided	Braided	Monofilament	Monofilament	Monofilament	Monofilament
Composition	Polyglycolid Acid	Polyglycolid Acid	Glyconate	Glyconate	Polydioxanone	Poly-4 Hydroxybutyrate
Coating	Glyconate	Glyconate	Uncoated	Uncoated	Uncoated	Uncoated
Colour	Undyed	Violet or Undyed	Undyed	Violet or Undyed	Violet	Violet
Sizes	USP 7/0 to USP 2 Metric 0,5 to 5	USP 10/0 to USP 2 Metric 0,2 to 5	USP 6/0 to USP 1 Metric 0,7 to 4	USP 7/0 to USP 1 Metric 0,5 to 4	USP 7/0 to USP 2 Metric 0,5 to 5	USP 2/0 to USP 1 Metric 3 to 4
Degradation profile	50% after 5 days 0% after 10–14 days	50% after 18 days 0% after 28 days	50% after 6–7 days 0% after 14–21 days	50% after 14 days 0% after 28 days	50% after 28–35 days 0% after 70 days	50% after 90 days 0% after 180 days
Mass Absorption	Hydrolysis 42 days	Hydrolysis 60 to 90 days	Hydrolysis 56 days	Hydrolysis 60 to 90 days	Hydrolysis 180 to 210 days	Hydrolysis (enzymatic reaction) in approx. 13 months

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B. Braun Surgical SA | Carretera de Terrassa, 121 | 08191 Rubí | Spain
Phone +34 93 5 86 62 00 | Fax +34 93 6 99 73 03 | www.bbraun.es

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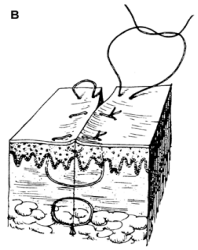
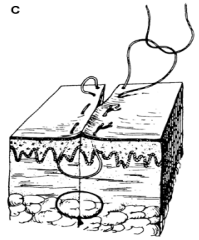
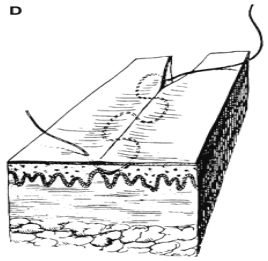
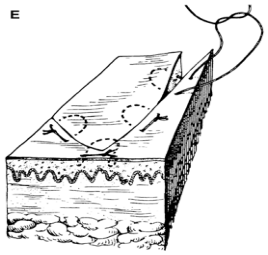
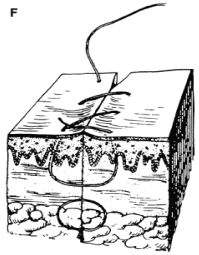
APPENDIX 4 A

Colour		Name	Raw material	Classification	Absorption	Uses
Yellow		Plain Gut PLAIN	Collagen from sheep and cow submucosa and serosa	**ABSORBABLE**, NATURAL, MONOFILAMENT	Tensile strength = 5-7 days Absorption = 70 days	Moderate tissue reaction must be balanced against rapid absorption and low cost. The only real use is oral and vaginal mucosa approximation commonly with continuous running suture.
Brown (Ugly!)		Chromic Gut CHROMIC	As above, but treated in a bath of chromium salt	**ABSORBABLE**, NATURAL, MONOFILAMENT	Tensile strength = 10-14 days Absorption = 90 days	
Purple		Polyglactin 910 RAPIDE VICRYL	Copolymer of glycolide and lactide coated with polyglactin 370 and calcium stearate.	**ABSORBABLE**, SYNTHETIC, BRAIDED	Tensile strength = 10-14 days Absorption = 42 days	Essentially the same use as gut, has minimal reaction but cost 5 x more. Useful as a skin suture in young children as removal of sutures can be traumatic (in both contexts!).
Red and purple candy stripes (Pretty!)		Polyglactin 910 VICRYL (Coated)	As above	**ABSORBABLE**, SYNTHETIC, BRAIDED	Tensile strength = 21 days Absorption = 56 days	Good general approximation of muscle and subcutaneous tissues. Not for sheath, tendon, ligament or intradermal use.
Coral Pink		Poliglecaprone-25 MONOCRYL	Copolymer of glycolide and epsilon-caprolactone.	**ABSORBABLE**, SYNTHETIC, MONOFILAMENT	Tensile strength = 21days Absorption = 91-119 days	Also good general approximation of above tissues. Mainly used for sub-and intradermal sutures.
Silver		Polydioxanone PDS II	Polyester polymer.	**ABSORBABLE**, SYNTHETIC, MONOFILAMENT	Tensile strength = 6 weeks Absorption = 6 months	Useful for bowel anastomosis, sheath closure and some soft tissue repairs where extra healing time is needed. NOT for dermal suturing.
Plum		PANACRYL No generic name	Copolymer of lactide and glycolide coated with a polymer of caprolactone and glycolide.	**ABSORBABLE**, SYNTHETIC, BRAIDED	Tensile strength = > 6 months Absorption = 1.5 – 2 years	Useful where extended healing time is needed. Applications include sheath closure, some tendon and ligament repairs.

APPENDIX 4 B

	Vertical Mattress	Vertical mattress sutures are used when eversion of the skin edges is needed and cannot be accomplished with simple sutures alone. Vertical mattress sutures leave obvious cross-hatching and must be removed early.
	Horizontal Mattress	Horizontal mattress sutures also provide approximation of the skin edges with eversion. They are particularly advantageous in thick glabrous skin (located on the sole and palm). However, they produce more ischemia of the wound edges (but are useful for haemostasis!).
	Subcuticular	For subcuticular (intradermal) sutures the needle is passed horizontally through the superficial dermis parallel to the skin surface to provide close approximation of the skin edges. Care must be taken to ensure that the sutures are placed at the same level. Such a technique circumvents the possibility of suture marks in the skin.
	Half-Buried Horizontal Mattress	Half-buried horizontal mattress sutures are used when it is desirable to have the knots on one side of the suture line with no suture marks on the other side. The best use of such a suture is to suture down the tip of a triangular flap of tissue – this is eponymously known as a Barron's Suture.
	Continuous Over-and-Over Suture	Continuous over-and-over sutures can be placed rapidly and provide hemostasis by compression of wound edges. They are especially useful in scalp closures and for closure of oral & vaginal mucosa. They should not be placed on cosmetically important skin as they cause cross-hatching.

APPENDIX 5